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PLANNING, DEVELOPING, AND OPERATING
A COMBINATION AIR-GROUND DETECTION SYSTEM

U.S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE, NORTHERN REGION

Missoula, Montana

January 1954

PLANNING, DEVELOPING, AND OPERATING

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PLANNING, DEVELOPING, AND OPERATING

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INTRODUCTION

Aerial detection is not new to the thinking of fire planners. In fact it has been tried off and on for many years. Results of early experiments were not always bad, although efforts along this line were of short duration until 1945 when Region 1 started the "Continental Area."

The Continental Area was selected to develop the necessary planning methods, and test the possibilities of combining two methods of detection--air and ground. It was hoped that this combination, utilizing the superior points of each method, would result in an answer to at least part of the modern problems of fire detection.

To this end the Continental Area was successful. Although a combined air-ground detection system, as now operated in Region 1 and elsewhere, is far from being foolproof, the system has been accepted by the field because of its many advantages. ~~Region 1 now has 12 units which~~ ALL REGION ONE FORESTS NOW use air-ground detection.

These units are administered by forest personnel and as a result, considerable variation exists in basic plans and operational procedures. To assist local administrators in applying best-known methods, this planning guide has been developed. It is designed to assist in modernizing, replanning, and maintaining units already established. It will assist administrators in exploring the possibilities of combined air-ground detection units.

THE COMBINED AIR-GROUND DETECTION SYSTEM - WHAT IS IT?

~~Special aerial patrols or reconnaissance flights have been made during extreme fire dangers or following intensive lightning storms, for many years with only moderate success.~~ With the combined system, ~~the~~ aerial reconnaissance is planned and financed as part of the regular day-by-day detection system. Many variations are possible and rightfully so. Areas with heavy man-caused fire risk and heavy fuels at low elevations require more "fixed" detectors than areas where the occurrence is nearly 100 percent lightning-caused and is largely confined to mountain tops with short burning seasons. We therefore have some units where the airplane supplements the ground detectors, and others where a few ground detectors supplement the airplane. Present plans do not contemplate a 100 percent aerial detection system because some ground detectors are required to measure weather factors, observe and record the path and intensity of lightning storms, locate and report lightning-strike areas, provide the radio communications network, provide high-frequency coverage where necessary, and in some cases provide smokechasing and ground-patrol coverage.

The present air-ground detection system is therefore one where air and ground detectors are used in combination to realize the benefits of each.

ADVANTAGES OF THE COMBINED AIR-GROUND DETECTION SYSTEM

Since 1945, when the so-called Continental Area was started, the planned use of airplanes for detection has increased by leaps and bounds. This has not been due to pressure from regional offices, but has resulted from enthusiasm and interest by field men and other problems which complicate the management and financing of ground lookouts. Forests have, in fact, been cautioned against advancing too fast until more evidence could be obtained regarding the benefits and weaknesses.

Results have indicated the following advantages when viewed in the light of present-day financial and personnel problems.

1. Flexible. Air detection may be expanded or curtailed as required on short notice. During periods of low fire danger, flying hours are "banked" for use when needed. Planes and observers may economically be made available for early- and late-season fires, and for emergency detection such as might be required during a dry hunting season.

2. Economical. Modern 4-place airplanes are economical to operate. Contracts may be secured for ~~$18~~ $25 to ~~$22~~ $35 per hour with qualified pilots. Extensive coverage during daylight hours comparable to that provided by fixed detectors (considered theoretically as one look per hour) is less expensive than maintaining improvements and manning the system required with fixed detection. During so-called "easy" periods, flying is reduced to security checks or discontinued. Ground detectors cannot be "hired and fired" with fluctuating fire dangers. Savings by reduction of fixed detectors usually provide for additional smokechasers as well as the air patrol.

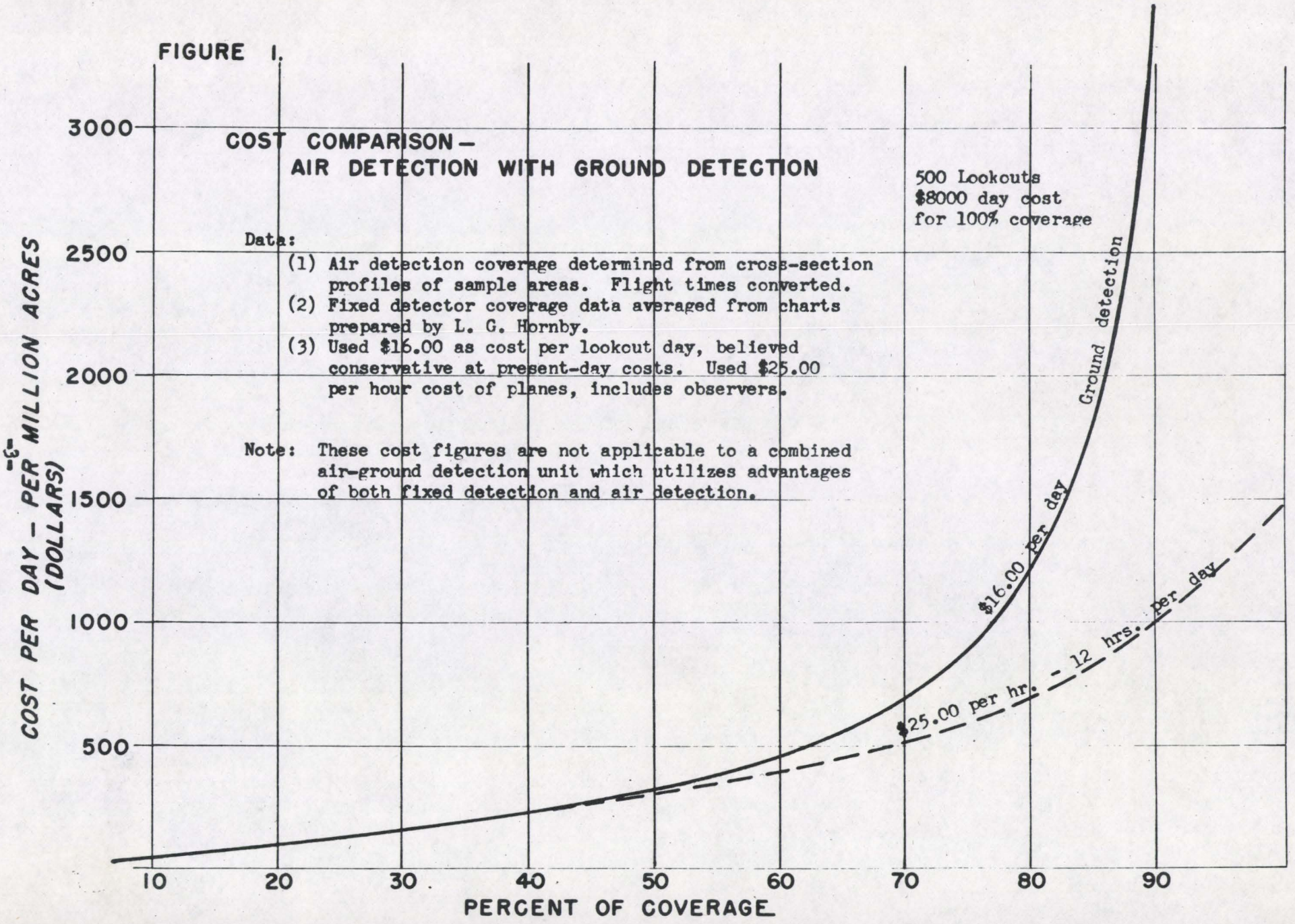
   The use of airplanes for observation makes it economically possible to provide 100 percent coverage wherever and whenever necessary during daylight hours. Usually aerial detection recognizes a reduced frequency of observation. Any system of fixed detectors only will require supplemental air patrol to obtain 85+ percent coverage economically. See figure 1.

3. Fire-probability calculations made more accurately. The air observer can report conditions of fuels, slopes, barriers, size, and other factors more accurately than fixed detectors reporting from greater distances.

4. Smokechasing facilitated. Air observers can often report best cross-country travel routes and unmapped roads in the immediate vicinity. Several cases were reported where the air observers directed smokechasers to hard-to-find smokes.

5. Fire reconnaissance (scouting). Patrol planes check daily every going fire while on patrol or upon request, and report latest information on progress. Several instances are known where observers are credited with preventing larger fires by timely reporting of adverse developments.

FIGURE 1.


COST COMPARISON—
AIR DETECTION WITH GROUND DETECTION
Data:
(1) Air detection coverage determined from cross-section profiles of sample areas. Flight times converted.
(2) Fixed detector coverage data averaged from charts prepared by L. G. Hornby.
(3) Used $16.00 as cost per lookout day, believed conservative at present-day costs. Used $25.00 per hour cost of planes, includes observers.
Note: These cost figures are not applicable to a combined air-ground detection unit which utilizes advantages of both fixed detection and air detection.
500 Lookouts
$8000 day cost
for 100% coverage
Ground detection
$16.00 per day
$25.00 per hr. - 12 hrs. per day
COST PER DAY - PER MILLION ACRES (DOLLARS)
3000
2500
2000
1500
1000
500
10
20
30
40
50
60
70
80
90
PERCENT OF COVERAGE

6. Patrol planes are available for other jobs in connection with patrol trips or when not needed for detection. Since they are given contracts for a considerable amount of flying, rates are usually more reasonable.

Aerial delivery - freight and supplies. Patrol planes ~~often~~ may deliver much-needed drinking water and small amounts of subsistence or tools to smoke-chasers on fire duty. In one unit 30,000 pounds of airfreight were hauled to outlying fields or lookouts during the season. Mail and fresh subsistence delivered to lookouts boosts morale at minimum cost, since much of the flying is done in connection with scheduled patrol trips.

Air reconnaissance to scout possible locations for access roads, insect survey, timber survey, search and rescue, and orientation flights for new personnel has been accomplished at reasonable cost by patrol plane.

Safety. Planes and pilots are carefully selected and inspected before contract and currently throughout the season.

7. Smaller investment in improvements required. With combined air-ground detection a much smaller number of lookout structures and related improvements is required (approximately 10 lookouts per million acres as compared to 30) for the class ~~70~~ AVERAGE SEASON organization.

8. Number of lookout-firemen reduced and smokechasers increased. A smaller number of lookout-firemen is required, which provides maximum opportunity to obtain qualified men through selection. Smokechasers, located at stations where mobility and maximum use are possible, are increased through savings made by air detection.

9. Training of lookout-firemen is intensified since supervisors have only one-third the number to visit and inspect.

10. Better lookout improvements are possible with reduced budgets since smaller numbers are required. Maintenance problems due to shortage of skilled help are reduced.

DISADVANTAGES OF AIR-GROUND DETECTION SYSTEMS

Air-ground detection is new. Sufficient experience to answer all the problems or questions is not yet available or arranged in a form suitable for planning purposes.

Disadvantages are:

1. Night flying is not yet considered safe. Although tests indicate that fires are easily detected at night, present policy and methods allow air patrol only during daylight hours. This results in a delay in the discovery of fires, not seen by fixed detectors, which start at night.

2. Patrol planes are sometimes "weathered in" when detection may be desired on some part of the area. In a few cases takeoffs have been delayed because of dangerously high winds.

3. There is a continual pressure for larger planes or multi-engined planes for patrol. Although these would increase safety of flying somewhat, the higher costs would certainly result in a reduced frequency of observation. With experience we may determine that larger planes are feasible.

4. A good central dispatcher is necessary to the successful operation of the air-detection unit. We find these men are often too busy with other work to devote the necessary time to planning, recording, evaluating, and improving the system.

5. In some areas there is a shortage of communication equipment for most effective operation, although administrators have been forced to air-ground detection because of other advantages.

6. Reduced observation time for that area which was originally covered by ground detectors. At lower fire dangers air patrol usually consists of only one or two trips per day.

7. Reduced number of cross shots, due to smaller number of lookouts, created problems common to "one-shot" locations.

8. Observer fatigue limits effective flying time and is an important consideration in aerial detection due to speed of travel.

PLANNING AND DEVELOPING THE AIR-GROUND DETECTION SYSTEM IN REGION 1

~~The region has few guidelines to follow in planning and developing an air-ground detection system.~~ Fire-control personnel engaged in planning the AN unit will find great opportunities for original thinking and development work. Many questions are not yet answered. For example:

How can ~~we more accurately determine~~ the frequency of observation S required for a burning ~~index~~ of 20, 40, 60 or 80? BE DETERMINED.
SPREAD INDICES

At what time of day, considering all factors of fire danger, season, elevation and intensity of the lightning storm, should ~~we fly~~? What are the indicators? OBSERVATION FLIGHTS BE MADE?

How long ~~should we~~ intensify IED observations following lightning storms? BE USED

Of course, with experience and analysis of discovery action, the answers will someday be revealed - providing someone has time for the study. For the present, PLANNERS we must use the best experience available and depend upon administrators to watch carefully the fire action and take immediate corrective measures as indicated.

Present instructions for fire planners are:

1. The combined air-ground detection system must be financed with current allotments to the unit and provide commensurate initial-attack personnel. If possible there should be some savings to finance radios, binoculars, new firefinders, and other equipment needed to improve present facilities.

2. Reductions in lookout-fireman positions should be carefully planned. If new positions (locations) are required they will be investigated thoroughly. Make full use of improvements already provided if possible. When new structures are built the plans should be reviewed carefully to make sure that the location is one that will stay in the plan for several years.

3. Any savings made by reducing the number of lookout-firemen should be used to provide:

   a. air-patrol needs including flight hours, observers, and relief as necessary;

   b. ground patrol in special risk areas as needed; and

   c. additional firemen at headquarters stations or strategic smoke-chasing points.

4. The savings provided will not be used to increase periods of employment or for additional overhead positions.

Much has been written about planning principles upon which forest-fire lookout systems should be based to meet detection needs. A review of these writings is well worthwhile.

HORNBY, L. G., Fire Control Planning in the Northern Rocky Mountain Region, Progress Report No. 1, 1936.

SHOW, S. B., KOTOK, E. I., GOWEN, G. M., CURRY, J. R., and BROWN, A. A., Planning, Constructing, and Operating Forest Fire Lookout Systems in California. 56 p.p. Illustrated, U.S.D.A. Circular No. 449, 1937.

SHOW, S. B., and KOTOK, E. I., Principles of Forest Fire Detection in the National Forests of Northern California. 32 p.p. Illustrated, U.S.D.A. Technical Bulletin No. 574, 1937.

BARROWS, J. S., Forest Fires in the Northern Rocky Mountains. Northern Rocky Mountain Forest and Range Experiment Station Paper #28, April 1951.

HAND, R.L., and HARRIS, H. K., Preliminary Report on Aerial Detection Study. Fire Control Notes 8(1):28-32, January 1947.

OBJECTIVES AND PROBLEMS OF DETECTION PLANNING

The region has been faced with many problems in connection with the ground-detection system. Chief among these are:

1. Lookout structures, mostly built during CCC and NIRA days when a heavy development program was under way, are now reaching a point where maintenance costs are prohibitive and a safety problem is ever present. Chances for the necessary and adequate maintenance or reconstruction funds appear very slight.

2. Our scale of wages is not as high as industry. We are faced with a shortage of qualified or experienced lookout-firemen at the present time.

3. We need more smokechasers centrally located, and with transportation, for more effective fire action. It became apparent long ago that lookout-firemen were being sent to fewer and fewer fires and, with the road developments, most initial control action originated from headquarters stations.

4. The 40-hour work week has reduced the effectiveness of ground detection. Relief lookouts are expensive and not always available.

5. Present policy of manning in accordance with fire danger presents problems of employment. Fixed detectors cannot be hired and fired at will or placed and removed quickly enough to conform to rapid fluctuations in fire weather. On many districts other funds are insufficient to keep the full quota of men available when needed for short periods of high fire danger.

6. There is insufficient time for proper training, supervision, and inspection of widely scattered lookout-firemen.

Any new plan, such as the proposed air-ground detection plan, should consider the above problems as well as ways and means to improve fire detection. Objectives are outlined as follows:

1. Provide high-frequency or fixed coverage of the important forest areas equal to or better than that previously provided by the ground-detection system. Substitute air patrol in areas of lightning risk and where fuels and burning periods present less likelihood of project fires.

2. Plans should provide necessary background material for proper supervision, sufficient hours of patrol, and training to realize the advantages and minimize the disadvantages of air patrol.

3. Provide for pre- and post-season fire detection.

4. Provide for emergency situations such as heavy fire concentrations, above normal fire dangers, and unexpected man-caused risks.

5. In general, provide the same quality of detection at a reduced cost or improve detection for the same cost.

PRELIMINARY PROCEDURES

Planners should first familiarize themselves with available maps, charts, seen-area composites, and written plans. Spot maps, weather information and fire statistics should be brought up to date. In some cases information such as weather forms (~~120-R1~~ WB 612-17) may have to be obtained from the regional office.

Accurate mapping is the first step in setting up a detection plan for any area. Whenever possible, topographic base maps should be provided. If these are not available, reliance must be placed upon the best drainage maps that can be obtained. A scale of 1/2 inch per mile is satisfactory for most work. Maps of larger scale than 1 inch per mile or smaller than 1/2 inch per mile should not be used as base maps.

DETERMINE IMPORTANT AREA AND MAKE IMPORTANT-AREA MAP

Any detection plan must segregate and define the areas to be covered. Early planning treated all areas alike and did not differentiate between long- or short-season areas, or areas which because of value, occurrence, or fuels, constituted the most important area from a detection standpoint.

In air-detection planning, the so-called important areas are defined and mapped for use in the selection of fixed detectors and to determine the number needed.

Important areas include the following:

1. Areas of heavy fire occurrence as indicated by the past record.

2. Current logging operations with dangerous slash accumulations.

3. Areas of ~~H-M (high-spread medium-resistance) or worse fuels~~ IN 1/2 AND 1 HOUR CONTROL ZONES, including slash accumulations not likely to be disposed of in the near future.

4. ~~Areas of high values such as experimental forests and recreational sites.~~ CLASS 4, 5, + 6 RESOURCE VALUES

General practice has been to develop the important-area map as overlays or tracings arranged for proper orientation on a base map of the entire area. After the overlays are completed the information may be transferred to a permanent record if desired. This facilitates the selection of lookout coverage and the development of coverage composites since all important-area information is then on the base map used under the composites.

FIRE-OCCURRENCE-ZONE MAP

The fire-occurrence-zone map is used in the determination of detection values for the area under study. It is one step in the development of the important area. Individual fire reports are the basis for this map.

The most recent 10-year record of man-caused fires and 20-year record of lightning fires should be used. All fires which represent a risk subsequently removed should be eliminated. Fires caused by old logging operations, right-of-way clearing fires, etc., are examples. (Some Region 1 forests have very carefully

made spot maps which show the fire occurrence by location on 1/2-inch-scale maps. Where these are available the overlay may be made direct with a considerable saving in time.)

It may be desirable to separate the man-caused fires into two groups, each representing 5 years' occurrence, to serve as a check on current trends. Planners acquainted with the area or familiar with current prevention plans will be able to determine this need.

On the overlay, indicate the location of lightning-caused fires by a small "x" and man-caused fires by a small "o." Fires, either man-caused or lightning-caused, which reach a size of 10 acres or more should be shown in red; otherwise the size of the fire is disregarded. The information on size is helpful in establishing areas where early discovery is essential.

The distribution and pattern of spots on this record is studied in relation to the localities concerned. It will be possible to outline groups of fires by localities, and often within narrow limits, to determine where man-caused fires are most likely to occur. The lightning fires must be zoned more mechanically, although a 20-year record of lightning occurrence will reveal definite areas and trends.

In practice an attempt is made to place a boundary around each group of spots. The usual practice is to locate this line at one-half the distance between spots although these mechanical boundaries are subject to alteration by interpretation. The areas defined in this way are termed "zones of occurrence." Areas where the occurrence is less than 2 fires per section (640 acres) are not feasible to define into an occurrence zone.

The next step is to rate the various occurrence zones with respect to their importance in the detection plan. The zones are usually rated according to the number of fires per 1,000 acres per 10-year period. (Since we used 20 years of lightning occurrence to get better fire distribution, and only 10 years of man-caused occurrence, the lightning-caused fires are counted as 1/2 fire.)

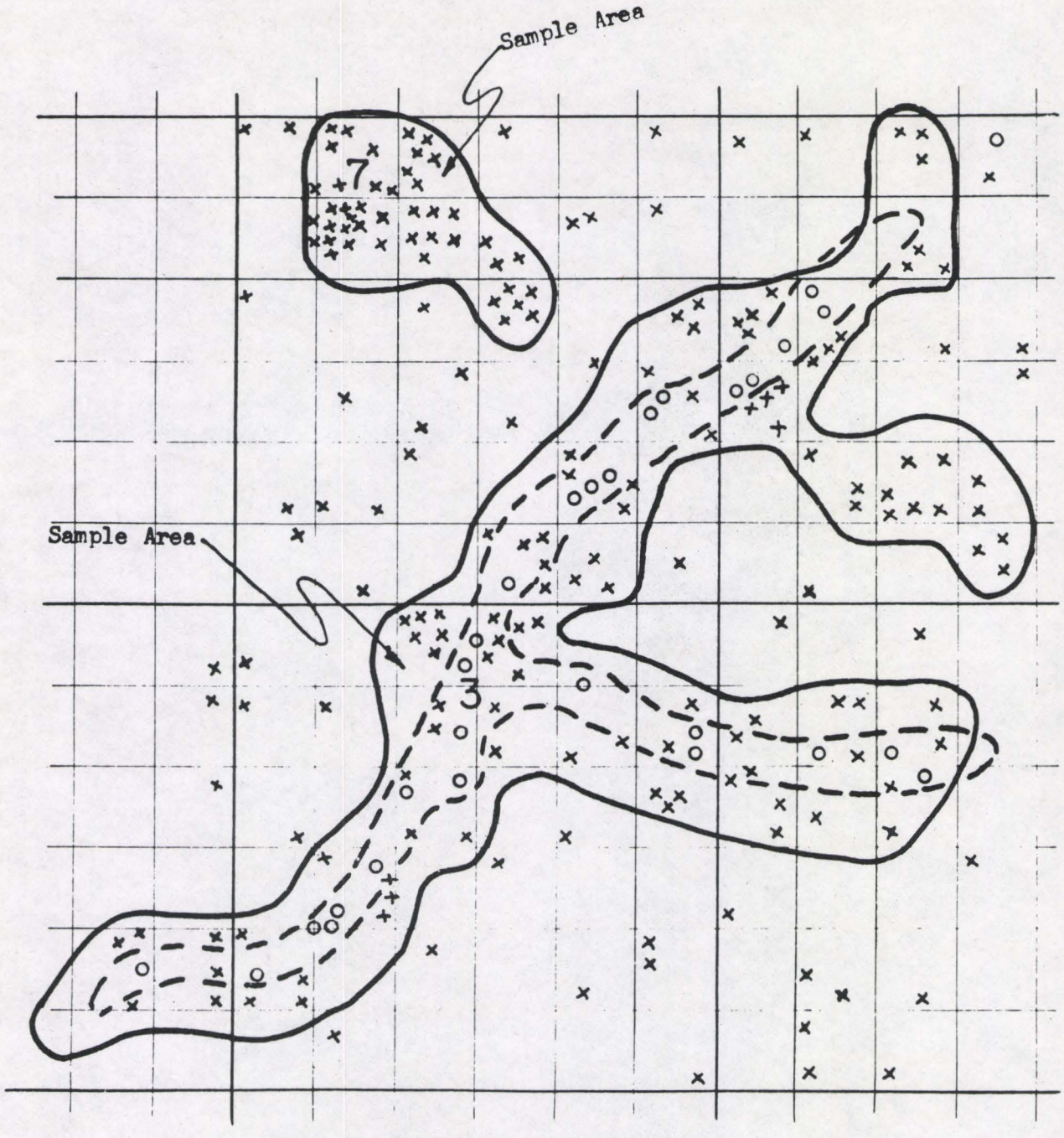
See figure 2 which shows a sample of occurrence-zone mapping for illustration. In this figure, two occurrence zones are shown (enclosed by solid line). The sample area has been rated "7." Calculations were as follows:

A total of 44 fires in the 20-year period is equal to 22 fires per 10-year period. Area is 3,000 acres. $22 \div 3 = 7.3$ fires per thousand acres per 10-year period. Ratings of .5 are given the next class. Ratings of .4 or less are disregarded. The sample area was therefore given a rating of 7.

The large area shown on figure 2 contains 28 man-caused and 104 lightning-caused fires in an area of approximately 25,000 acres. Man-caused fires were recorded for a 10-year period only; therefore total fires for a 10-year period in this zone is 80 ($52 + 28$). $80 \div 25 = 3.2$ fires per thousand acres per 10-year period. The zone is therefore rated as 3.

It is helpful in selecting lookouts if areas where occurrence rating of 5 or more fires per thousand acres are lightly colored in red.

FIGURE 2


Sample Area
Sample Area
7
3
Boundary of occurrence zone
Boundary of man-caused hazard zone
Lightning-caused fires
Man-caused fires

An alternate method for use in rating and delineating occurrence zones has been used in Region 1 with good success. This method rates fires per thousand acres per 20-year period, and outlines areas on section boundaries. Advantages are that planimetering is reduced and calculation of area values under a seen-area composite or map is simplified.

Figure 3 illustrates this method for your consideration. It is believed that accuracy of this method is comparable, although the method has been used on only one forest (the latest planned unit) up to time of this report.

In figure 3 the smaller occurrence zone contains 6 sections or 3.8 M acres. The area contains 44 lightning-caused fires in the 20-year period. 44 fires ÷ 3.8 M acres = 11.5 or an occurrence-zone rating of 12. The larger zone contains 152 fires (man-caused fires counted as 2 fires, since only a 10-year period is shown) in an area of 28 sections (17,920 acres). 152 fires ÷ 18 M acres = an occurrence-zone rating of 8.

Since a 20-year period of fire occurrence is used, areas rated 10 or more are colored light red to indicate important area from an occurrence standpoint.

It might be well to note at this time the area (indicated by the dashed line) which represents a man-caused risk. Further development of the important-area map will consider this area, as well as zones rated 10 or more, as important from a detection standpoint.

IMPORTANT-AREA OVERLAY

Sound planning dictates that other areas require accelerated or near-constant coverage. This type of coverage can best be done by fixed detectors. Examples:

1. Current logging operations. If of sufficient importance or risk, temporary detection arrangements should be considered. Risks of relatively short duration should be carefully considered in planning the basic improvements (lookouts, etc.,) which will be required for a considerable period.

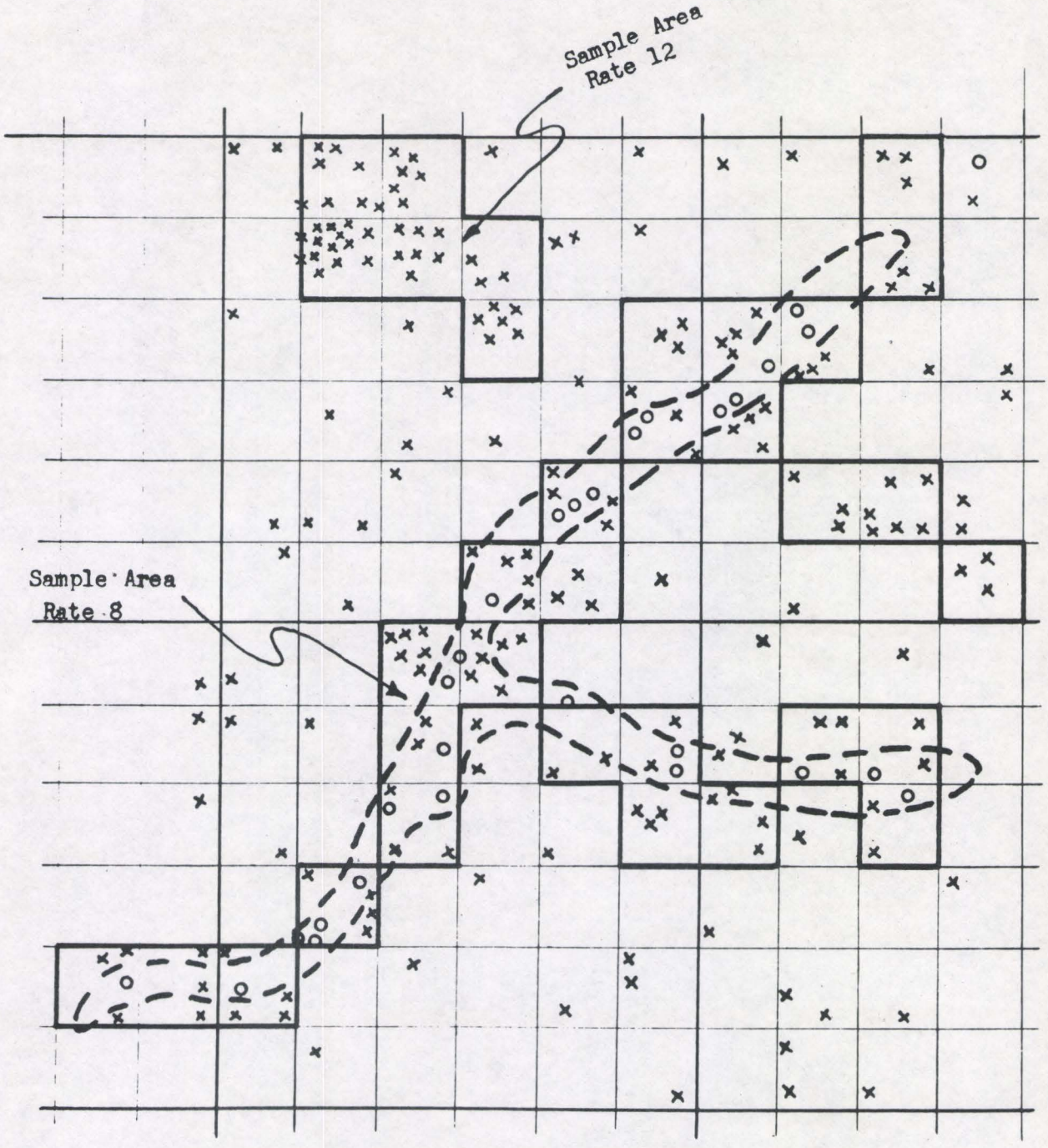
2. ONE HALF AND ONE HOUR CONTROL ZONES ~~H-M (high-spread medium-resistance) fuels or worse~~, whether caused by accumulated slash or from natural causes. If these dangerous fuels are basically slash accumulations, planners should consider carefully the duration of the risk. Do not include logging slash which is scheduled for disposal within 2 years.

3. AREAS OF CLASS 4, 5, & 6 RESOURCE VALUES ~~Areas of high values such as established experimental forests and recreational sites.~~

These areas should be indicated either directly on the base map or on a tracing. Red cross-hatching will differentiate from high-risk occurrence zones and at the same time bring these areas to the attention when selecting lookout or patrol coverage.

In outlining the areas, confine the boundaries to the minimum area possible.

FIGURE 3



——— Boundary of occurrence zone

– – – Boundary of man-caused hazard zone

✝ Lightning-caused fires

○ Man-caused fires

SELECTION OF FIXED (GROUND) DETECTORS

Most regions have completed rather intensive field work and seen-area mapping of promising lookout points. Using the seen-area silhouettes or maps showing the seen area from these points, we must select a ground-detection system which will give a high percentage of coverage of the important area.

In this connection the seen area obtained by 30 lookouts per million acres (an average for ~~class 70 danger~~ NORMAL AVERAGE SEASON with the ground-detection system) seldom exceeded 55 percent coverage in the rough topography associated with Region 1. Addition of more lookouts produced less and less additional coverage as each point was added. It has been determined that approximately 70 percent coverage of the important area is possible, in most areas, by a relatively small number of lookouts (approximately 10 per million acres). It is also likely that coverage from these key stations will produce approximately 75 percent of the first discoveries, since the important areas represent the greatest risk, and heaviest occurrence. The areas where fires are most likely to occur are assigned to the key network of fixed detectors.

Planners cannot be too careful in the selection of these lookouts and it is well worth considerable effort to weigh the coverage for each individual point and review other locations which have been eliminated in past planning.

Techniques and methods of visible-area mapping are available for use in field survey work. Field sketching is recommended under most conditions as the best method for making visible-area maps. This should be done by experienced personnel if possible. The selection of new positions should be done only after a careful study of the occurrence zones, the zone ratings, and the important-area map.

If time is available, the seen-area maps from which the final selection and seen-area composites will be made, should be checked on the ground and visibility distance increased to 20 miles. If it is impractical to do the field checking, planners should extend the coverage from 15 to 20 miles by using the profile method of seen-area mapping. The high percentage of smokes seen at distances greater than 15 miles prove conclusively that this seen area should be considered in planning the air-ground detection unit. Remember too that the air patrol can serve as "eyes" for the lookout when distances are too great for accurate reporting from the ground position.

Planners who reserve judgement regarding the value of seen area beyond the usual 15-mile limits may show this area in a different color if they desire, but they should give it consideration in the selection of lookout positions.

METHOD OF COMPUTING LOOKOUT EFFICIENCY

Considerable thought has gone into methods of computing lookout efficiency. As a result of experimentation the method developed in the California Region with some slight modification appears to work as well as any in providing a mechanical rating on the efficiency of various possible detectors. This mechanical rating at least will serve as a check to the selection made by experienced planners.

Each visible-area tracing is placed in turn over the fire-occurrence (risk) zone map and the visible areas falling in each zone are planimetered or the acreage carefully calculated. These "visible fire-occurrence" areas are then weighed by the average number of fires per thousand acres actually occurring during the past 10-year period, and the weights being distributed according to the fire-occurrence classes already defined. For example, a lookout which covers 5,000 acres of a risk zone, rated as averaging 3 fires per thousand acres, would add a figure of 15 (3 x 5) to the accumulative total obtained by using the same process on other risk zones. The lookout which obtains the highest accumulative total or number would have greater importance in the combined air-ground detection organization than another which might have a larger acreage of seen area.

Planners should also take into account other important or high-value areas shown on the important-area map which are covered by the lookout, in deciding between two detectors of nearly equal ratings.

The alternate method of rating occurrence zones and lookout efficiency is used in essentially the same manner. The number of sections (640 acres) which occur within the seen area of the lookout are counted and the acreage determined. The number of fires also within the seen area are counted (each man-caused fire counted as 2 fires) and this number divided by the acreage in thousands to arrive at the rating for that area. The rating already established for each zone may also be used (to avoid counting individual fires) but the results will be slightly less accurate. It has been found that a combination of the two methods facilitates the work.

Seen-area maps usually have considerable area broken up into small patches due to rough topography. In these sections counting the actual fires and computing area by ocular estimate (counting full sections and adding parts) is faster than planimetering. In areas of solid seen area, such as a wide valley bottom, it will be simpler to determine area by counting sections (640 acres) or planimetering if desired, and applying the general rating for that occurrence zone.

Since the period is 20 years instead of 10, the figures will be larger but mechanical comparison between lookouts is the same.

DETERMINING THE NUMBER OF GROUND DETECTORS

The acreage, distribution, and rating of occurrence-risk zones and important or high-value areas largely determine the number of ground detectors required. Aerial units with little man-caused risk and with considerable area lying at higher elevations will require a smaller number of fixed detectors. Those areas with considerable man-caused risk, long fire seasons due to a higher percentage of lower-elevation country, and higher general fire dangers will require more fixed detection per million acres.

Until research or experience indicates a change is necessary, planners should attempt to obtain approximately 70 percent coverage of the important areas by ground detectors.

In building up the coverage composite, the lookout having the highest mechanical rating should be placed first, followed by those with the next highest and so on.

Where two lookouts have substantially equal ratings, a careful study of other important area should be made to determine the ratings. Other than the occurrence zones, the important areas are not rated mechanically. They should be given an order of importance as follows:

1. areas of heavy fire occurrence.

2. ~~1.~~ Areas of considerable man-caused risk in order of size and degree of risk.

3. ~~2.~~ Areas of ~~dangerous fuels~~ ½ AND 1 HOUR CONTROL zones.

~~a. In a high-occurrence area,~~
~~b. In a low-occurrence (less than 10 fires per 20 years) area.~~

4. ~~3.~~ AREAS OF CLASS 4, 5 + 6 RESOURCE VALUE
~~High-value or recreational areas~~ in order of size and estimated value.

If area of a new coverage per lookout is computed and mechanical ratings are compared, it is fairly easy to determine the point of diminishing returns. By adding new area seen, as each lookout is placed on the composite, and computing percent of total area, a simple graph may be constructed which illustrates the approximate number of lookouts which "buy" the most in seen area. Figure 4 illustrates the point of diminishing returns. In this hypothetical case, planners will probably decide to limit the lookouts at approximately 10 per million acres for the ~~class 70~~ AVERAGE SEASON organization.

Selection should be made at this time of highest priority emergency positions which might be required FOR EMERGENCY CONDITIONS ~~above class 70 dangers~~. Previous planning indicates that approximately 5 per million acres should be rated for further consideration. It is becoming a usual practice to place these emergency positions in accordance with local dangers and needs. Usually planners will also want to consider the smokechasing possibilities in making the final selection.

Composites of lookout coverage should ultimately be placed on linen tracing cloth. ~~Instructions issued during earlier planning regarding procedures are applicable to the present operation.~~

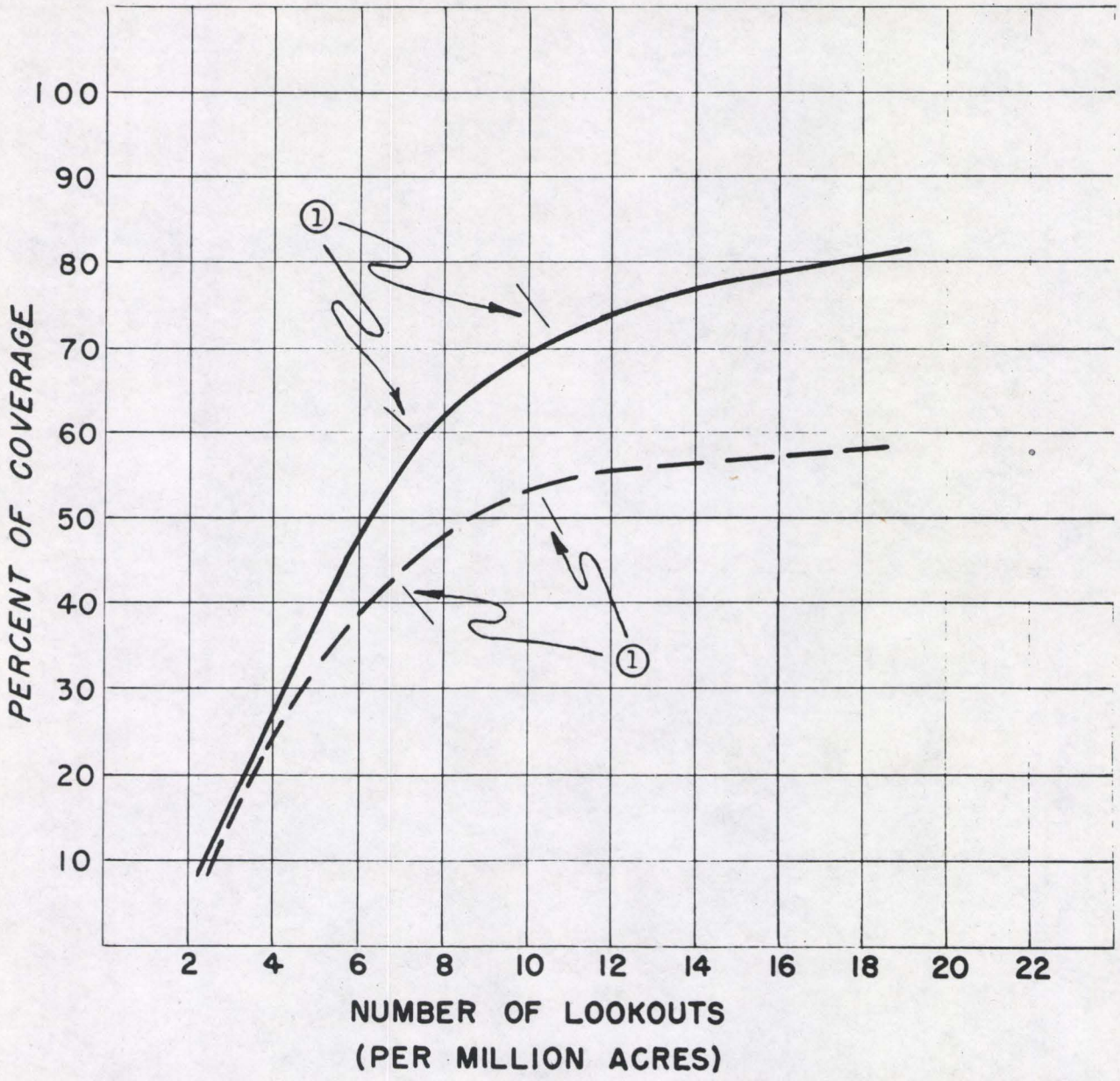
ROVING DETECTORS AND PATROLMEN

Experience of several years has indicated that forest patrolmen buy little in the way of detection. This does not mean that planners should disregard the possibilities for special conditions or situations. Radio communication will certainly do much to improve results.

A special field in which patrol functions well is in blind areas after lightning storms have passed over them. Here (1) fires usually spread slowly so that moderate delays in discovery are not critical; (2) the functions of detection and suppression may be performed by one individual; and (3) there is a greater probability that fires will be discovered. By means of radio the car patrolman can keep in touch with headquarters to receive coordinating instructions.

In the combined air-ground detection system, quite often a lookout-fireman can serve as patrolman along a stretch of ridge road, or move to another vantage point which observes area where lightning strikes have occurred.

FIGURE 4



——— Coverage of Important Area

— — — Coverage of Total Area

① Position on graph which represents point of diminishing returns.

These special situations should be analyzed and preparation made to obtain best use of the patrol time. Seen-area maps should be made from established observation points and the coverage recorded where it may be used by the dispatcher. When lookouts are used as patrolmen they should be scheduled away from the main point only when chances for fire discoveries are greater in the areas covered by patrol than they are from the lookout.

Long foot and horse patrols should be considered only in very rare instances. Foot patrols to vantage points within 15 minutes' walk of the lookout, and which make visible blind area in a risk zone, may be scheduled and considered part of the main point coverage. The possibilities, however, should not be overlooked and such patrols considered when planning detection coverage.

In some instances firemen have been scheduled on road patrol and, equipped with radio, they were able to keep in constant touch with headquarters. Careful supervision is required where this is practiced to avoid delays in report or travel time to fires reported by other means. There are possibilities under certain conditions and careful management for this type of patrol.

At this stage of the planning it is recommended that seen area from car or long foot patrols (foot patrols within 15 minutes of the lookout are considered and mapped as direct coverage) should not be included in seen-area composites. These patrols will be given further consideration, however, in planning for emergency conditions.

DETECTION BY LOOKOUT-FIREMEN

Early planning in REGION ONE ~~this region~~ considered the lookout as a fireman and many positions were manned largely from the smokechasing standpoint. The theory of the lookout-fireman system was that the detection and suppression functions could be combined in one individual, with full performance of each.

In the great majority of the cases the best place for the fireman did not coincide or even approximate the best location for the lookout. These lookout-fireman positions have been gradually removed from the detection organization, and the fireman stationed where he can take advantage of roads and thus increase the smokechasing coverage.

After a primary system of fixed lookouts is selected planners may find that a few firemen located on lookouts which cover additional and important blind area will be needed - particularly in areas a considerable distance from established guard stations. These lookout-fireman positions should be confined largely to areas where the fires are caused by lightning, and should be regarded as supplementing the primary lookout force. The position which provides road facilities for smokechasing should be considered before selection of points with only a limited area of smokechaser coverage. These selections are considered only for emergency-season placement.

LIGHTNING STORM COVERAGE

It should be the aim of the primary detection system to provide full information on any lightning storms which may cross the unit. This information includes (1) the location by drainage of lightning strikes and intensity of the storm;

(2) the width of the storm path and direction; and (3) the areas where good rains have occurred although these may not be measured at weather stations.

This information is of vital importance in scheduling air and ground patrols and routing planes. Adequate storm coverage may influence to a minor extent the selection of lookouts or lookout-firemen.

RADIO COVERAGE - COMMUNICATIONS

Radio communication must be established between patrol planes, ground patrolmen, ranger headquarters and the central dispatcher or air supervisor. It is important that the patrol plane contact each primary lookout for detailed storm information while on patrol and early enough to deviate from general patrol routes with a minimum of extra flying time.

Primary lookouts should be equipped with radio and scattered throughout the area enough to provide this communication with the patrol plane regardless of its location. This has presented little problem with modern radio communication and should influence selection of lookouts only in a minor way, if at all.

SUMMARY AND CHECK LIST - SELECTION OF GROUND DETECTORS

The important steps and considerations in the selection of ground detectors are summarized in order:

1. Spot fires on occurrence-zone maps
2. Outline occurrence zones
3. Rate occurrence zones
4. Color most hazardous areas
5. Color areas of man-caused risk
6. Prepare RESOURCE VALUE ~~important-area~~ overlay
7. Color ½ AND 1 HOUR CONTROL ZONES ~~H-M or worse fuels (hatching)~~
8. Check likely seen-area maps for 20-mile coverage
9. Select most likely lookouts, using important-area maps under seen-area maps of lookout coverage
10. Rate lookouts on occurrence and area covered
11. Determine acreage of important areas and total protection area in unit
12. Make seen-area composites starting with best lookout. Determine additional seen area added as each selected lookout is included
13. Build graph progressively and maintain tabulation to determine "point of diminishing returns" in lookout placement

14. Establish maximum ~~class~~ AVERAGE SEASON 70 lookout organization

15. Continue selection and establish priority of emergency positions.

ANALYSIS OF LIGHTNING-STORM OCCURRENCE

The analysis should be aimed to assist in establishing the normal-season requirement for patrol flying to cover lightning-storm areas. Tabulations and/or graphs should provide a partial basis for answering these questions:

1. How many days during the fire season should we anticipate lightning?

2. What will be the extent of the lightning-storm areas?

3. What frequency will days with lightning activity assume? Will several days follow one behind the other, or will the lightning storms be widely scattered, requiring supplemental flying almost daily to provide the necessary detection coverage? (Usual practice is to patrol lightning areas for 3 days following each storm which occurs during the fire season.)

On any day on which lightning occurred for 3 or more years out of 5, extra flying hours should be planned. The amount of flying will vary in accordance with the area to be covered as indicated by the number of districts covered by the storm.

To determine the amount of supplemental lightning-patrol flying, the number of districts hit by the storm are again analyzed. Lightning coverage is planned to cover the area needed 3 years out of 5 (approximately 10 percent odds in our favor).

See figure 5. In this sample the forest has 5 ranger districts. From WEATHER STATISTICS ~~forms 120-R1 and 124-R1~~, the tabulation has been made which shows the number of districts on which lightning occurred each day. From this tabulation the number of years in which lightning occurred is determined, also the number of districts, for use in planning the extent of lightning-patrol or supplemental flying.

ANALYSIS OF DANGER RATINGS

Planners should analyze the daily danger ratings for the past 5 or more years to determine so far as possible the anticipated ratings. These are used to determine to a large extent the normal-season flying required for air patrol. Sound planning dictates that unnecessary financing for air patrol be converted to smokechasers or used to finance emergency manning or flying.

Fire dangers (~~burning index ratings~~ SPREAD INDEX) can best be shown by date and year in graph form. Figure 7 illustrates one possible arrangement. The graph is prepared from tabulation as illustrated by figure 6.

Figure 5

TABULATION - LIGHTNING STORM OCCURRENCE

Date July	Years 1953	1952	1951	1950	1949			No. of yrs. in which lgtng. occurred	No. of Dist. which cover 60% of years	Days Anticipated Lgtng. Patrol
1	1	5	0	2	0			3	1	x
2	1	4	3	0	0			3	1	x
3	5	5	4	1	3			5	4	x
4	0	2	0	0	0			1	0	
5	0	1	5	0	0			3	1	x
6	3	0	5	0	0			2	3	
7	3	5	4	0	0			3	3	x
8	5	2	4	1	1			5	2	x
9	1	5	0	2	0			3	1	x
10	1	4	3	0	0			3	1	x
11	5	5	4	1	3			5	4	x
12	0	2	0	0	0			1	0	
13	0	2	5	1	0			3	0	
14	1		-	2				2	1	

Summary for July

Number of days and area for which lightning patrol should be planned

	11	days	with	area	approximately	1	district(s) (11)
	4	"	"	"	"	2	" (8)
	4	"	"	"	"	3	" (12)
	4	"	"	"	"	4	" (16)
Total	23	"	"	"	"	47	" (47)

Figure 6

TABULATION - DAILY SPREAD INDEX RATINGS

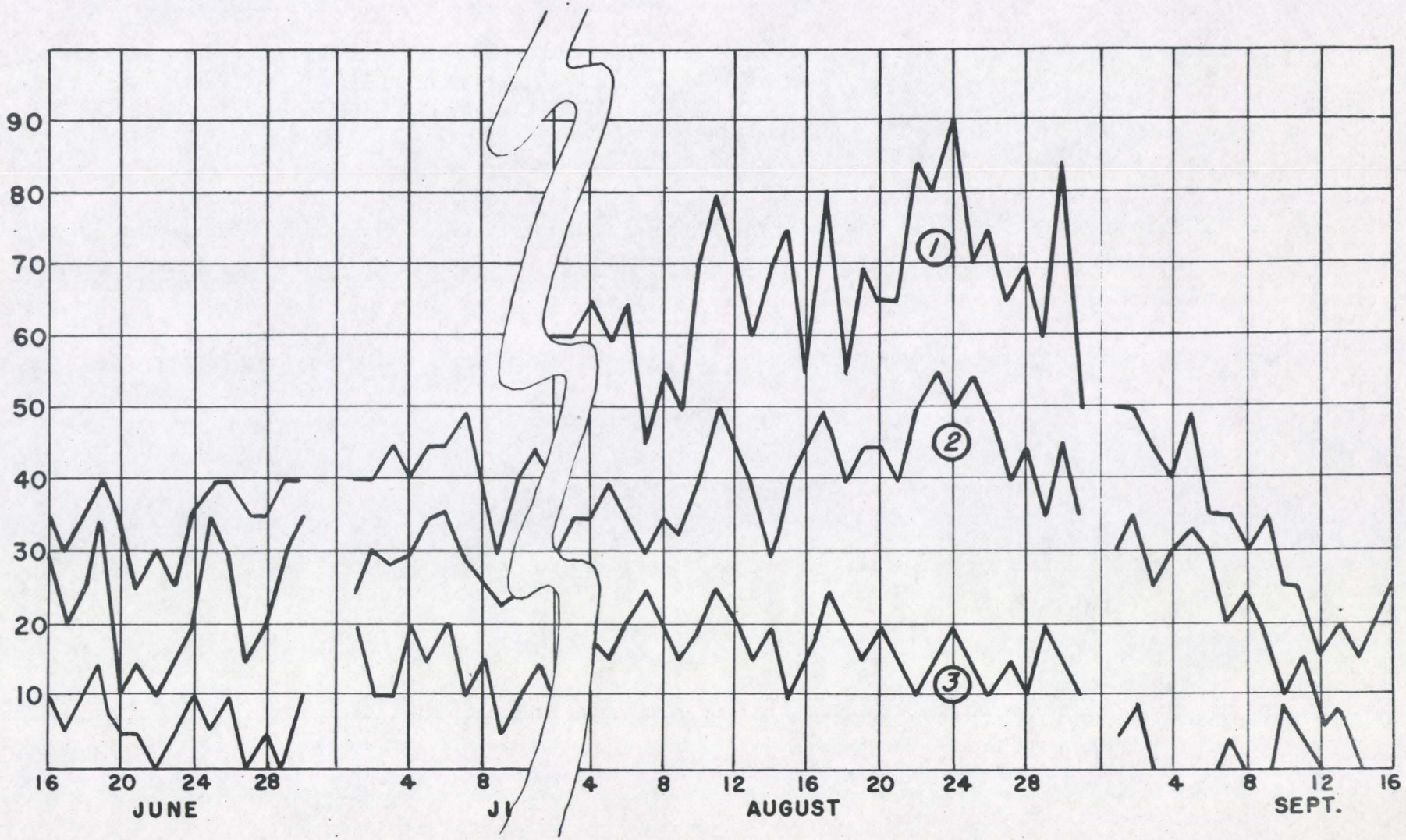
Date July	1953 Dist. No. 1	2	3	4	Forest Av.	1952 Dist. No. 1	2	3	4	Forest Av.	1951 Dist. No. 1	2	3	4	Forest Av.	1950 Dist. No. 1	2	3	4	Forest Av.	1949 Dist. No. 1	2	3	4	Forest Av.	Highest Rating on Forest	Forest Rating 60% of Years	Highest District Rating 60% of Years	Lowest District Rating
1	20	30	20	30	25	25	25	25	25	25	30	30	20	20	25	40	30	40	30	35	40	20	30	40	32	40	25	30	20
2	10	15	15	20	15	25	30	30	40	31	30	25	20	10	21	35	35	40	35	36	40	30	35	40	36	40	31	40	10
3	20	20	15	10	16	30	30	30	25	29	20	20	20	20	20	30	40	35	40	36	45	35	40	40	42	45	29	30	10
4	30	20	20	40	27	30	35	25	30	30	20	25	20	25	22	35	40	40	40	39	40	35	35	35	36	40	30	40	20
5	40	30	15	30	29	40	35	30	35	35	25	30	25	30	28	40	40	45	45	42	35	35	40	40	39	45	35	40	15
6	30	40	30	30	32	40	40	35	40	39	30	35	30	[illegible]	30	40	45	40	[illegible]	[illegible]	35	35	35	[illegible]	[illegible]	45	[illegible]	45	[illegible]
7	[illegible]	50	40	30	[illegible]	30	40	35	35	[illegible]	35	35	[illegible]	[illegible]	32	35	40	[illegible]	[illegible]	[illegible]	40	40	35	[illegible]	[illegible]	45	[illegible]	[illegible]	[illegible]
8	[illegible]	40	40	[illegible]	[illegible]	30	40	40	[illegible]	[illegible]	36	[illegible]	[illegible]	[illegible]	37	40	[illegible]	[illegible]	[illegible]	37	[illegible]	[illegible]	[illegible]	[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	30	[illegible]	[illegible]	[illegible]	[illegible]	40	30	[illegible]	38	[illegible]	[illegible]	[illegible]	[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Note:
Highest rating on the forest during the period indicates worst probable.
Lowest " " " " " " " " lowest " SPREAD INDEX
Flying (regular patrol) will be planned in accordance with B.I. ratings which may be expected on 60% of the years. The forest ratings and highest district ratings will provide guides to this planning.

FIGURE 7

ANALYSIS — DAILY ~~BURNING~~ SPREAD INDEX RATINGS

Highest Rating on Forest ① (worst probable)
Forest Rating 60% of Years ② (planned danger)
Lowest District Rating ③ (lowest probable)



AIR PATROL ROUTES

Two types of air coverage are contemplated as follows:

1. General patrol which recognizes the need for detection in accordance with the current fire dangers.

2. Lightning patrol which is planned for intensive coverage of lightning-storm areas.

PLANNING GENERAL AIR PATROL

General patrol routes and schedules should be planned to accommodate daily fluctuations in fire danger and the seasonal factors which are present in all units. This will require that several patrol routes be planned or arranged as follows:

1. An early-season general patrol which is planned to cover lower elevations and disregard the high elevations where burning conditions are such that detection is not yet required.

2. A mid-season patrol which is planned to provide general coverage of the entire area. With this patrol the frequency of observation for any part of the area will not be greater than twice per day. It is used during mid-season when fire dangers are below normal for the period, and lightning patrol is not required.

3. A mid-season patrol which is planned to provide general coverage of the entire area when fire dangers are above normal and greater frequency of observations is required. In general this patrol will be used following lightning storms (supplemented with additional flying for the lightning-strike areas) and for general security checks when fire dangers are above class 70 and lightning patrol is not required. In some instances emergency ground detectors may change the fixed-coverage pattern which should be given consideration.

4. A post-season patrol for general coverage during late season. This patrol differs from the early-season routes in that special conditions common to the late season must be considered. A suggested classification is shown in figure 8.

Patrol routes should be carefully planned and mapped for use by dispatchers, pilots, and observers. Planners will probably find that initial mapping can best be done on tracing paper laid over other maps which influence the selection of the flight routes. General procedures and instructions are as follows:

1. Using the coverage composite of area seen by fixed detectors as a base, select a flight path which will route the patrol plane through the largest of the areas not covered by fixed detectors. Consider each type of patrol as a separate problem in selecting the areas to be covered. Use 10 miles on each side of the plane as maximum discovery distance.

2. Using the important-area map in connection with the coverage composite (fixed detectors), adjust the patrol route in the area not covered by fixed detectors

Figure 8

SUGGESTED CLASSIFICATION OF AIR PATROLS

Patrol Class	Season of Use	Frequency of Observation	Description
A	Pre-season	1 per day	Very sketchy coverage for low fire dangers; no lightning; 0-30 danger - flight strip 20 miles wide.
B-1	Mid-season	2 per day	Moderate coverage for 30-50 dangers; no lightning-observation strip 20 miles wide.
B-2	Mid-season	2 per day	Semi-intensive coverage 50-70 dangers; no lightning - observation strip 10 miles wide; estimated 25% overlapping coverage.
C	Mid-season	2 - 4 per day	Intensive coverage; 70+ dangers; no lightning; flight strip 10 miles wide.
D	Post-season	1 - 2 per day	Sketchy coverage planned to meet existing conditions, hunting areas, etc. - flight observation strip 20 miles wide.
L	Any season	1 - 4 per day	Lightning - supplement to general patrols above.

to give maximum coverage of important areas. This is done by studying the map and positioning the flight path where the air observer will see the largest areas before being "cut off" by high ridges on either side.

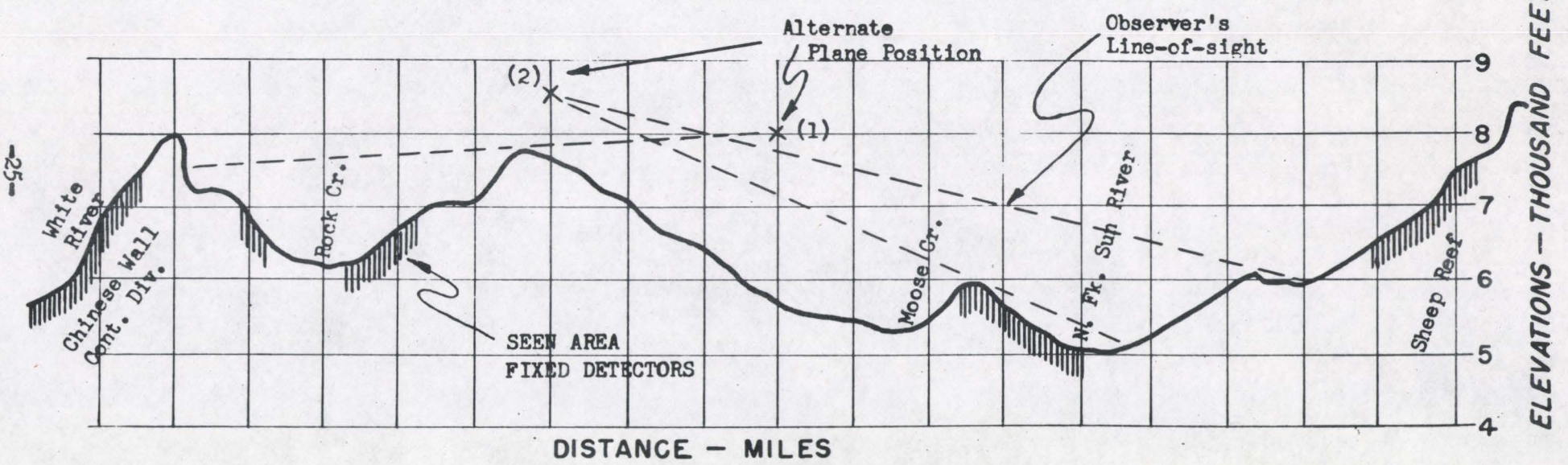
3. Make seen-area profiles at important points along the flight path. See figure 9. It is not recommended that extensive profile work be done at this time. This is a job for the air observer to do in connection with refinement of the patrol routes. It is important as a training aid and to the final development of total seen-area maps. Check points, where profiles can profitably be made now are established where important area is badly scattered and includes zones of high occurrence.

4. Determine length of each type of patrol and flying time required. Use 100-m.p.h. cruise speed and measure miles with dividers set to correspond to map scale.

5. Tabulate and designate various patrols, leaving space for later addition of fire danger ratings to be assigned each class or type of patrol.

FIGURE 9

CROSS-SECTION PROFILE — AIR DETECTION



PROFILE NO. ____

PLANNING LIGHTNING PATROL

Lightning patrols are generally considered as supplementary to the general patrol as planned for the existing period or fire-danger ratings. The additional flying is intended to allow detailed coverage of those areas where fixed detectors report lightning strikes. In practice the patrol plane proceeds along a "regular" patrol route until it reaches an area where lightning strikes are reported. The air observer will then deviate from the original route as needed to insure discovery of any lightning fire in the local area.

After giving this detailed or intensified coverage (5 miles each side) he proceeds again along the regular planned patrol route until he enters another part of the storm path or strike area.

You will remember in our analysis of lightning-storm occurrence we tabulated the number of districts covered by that day's storms. This was an attempt to determine the areas where extra flying might be necessary. The lightning patrol should be planned as needed to cover each ranger district thoroughly following the occurrence of lightning and the observance of strikes. Once the amount of supplemental flying per district is determined it is possible for the dispatcher to calculate the approximate flying required following any lightning storm, regardless of area covered, from information provided by the fixed detectors. This is important information for use in planning the number of planes required to provide a frequency of observation equal to one look per daylight hour. (This high frequency of observation may be necessary during short periods of high or extreme fire dangers. See "Frequency of Observation," below.)

To determine the lightning-supplement requirements, planners should study topography carefully and add side trips as necessary to provide the additional coverage. Planners should attempt to get approximately 80 percent total coverage. Most of this may be required of the air observer in areas where lightning is the principal fire cause.

VISIBILITY DISTANCE - AIR OBSERVERS

Although fires are often seen 20 or more miles away by aerial observers, for planning purposes, a distance of 10 miles on each side of the plane is usually considered as maximum. For intensive search such as lightning coverage or during emergency (70%) fire dangers, this distance is reduced to 5 miles. Consideration should always be given, however, to seen area within 10 miles of the observer in calculating frequency of observation.

FREQUENCY OF OBSERVATION

We need considerable research and study IS NEEDED to develop a good basis for calculations regarding frequency of observation. For present planning purposes, preliminary studies indicate that it is economically possible to obtain a frequency of observation from patrol planes equal to that obtained from fixed detectors during the daylight hours. For these purposes it was assumed that lookouts gave complete and detailed coverage of their seen area once per daylight hour. This standard has been established as a minimum requirement for lookouts.

On the other hand, the aerial observer in one patrol flight can cover many times as much area in one hour as that covered by the lookout. By arranging the flight pattern carefully, new areas are uncovered while a percentage of area covered on a previous swing is seen a second time but from a greater distance. Two planes, properly coordinated, can provide one look per hour over a considerable area. Due to the fact that the point of observation is constantly being moved to the most advantageous position, the total coverage is considerably more.

Planners should lay out a sample area and mentally "fly" the area at 100 m.p.h. to see the possibilities for "emergency" flying with a frequency of observation equal to one look per hour. See figure 10. This situation could not possibly be equalled by fixed detectors with high installation and maintenance cost, and considering the short period of use each season.

CALCULATING AREA SEEN BY AERIAL OBSERVERS

For planning purposes the area seen by the air observers when observing a strip 20 miles wide (10 miles each side of the plane) is calculated at 55 percent coverage. On patrols planned for observation of a 10-mile strip (5 miles each side of the plane) the coverage of that area is calculated as 75 percent. If intensive coverage of the entire area is planned, due to emergency fire conditions (see figure 10) the coverage is calculated at 90 percent.

These figures were obtained by mechanical mapping (use of frequent cross-section profiles) and interpolation between profiles using a contoured map. Sample areas were selected from various sections of Region 1.

Refinement of patrol routes and the air-coverage map should be a planned part of the air observer's duties. These will be covered in detail in the operations section. The coverage figures, used in planning, should be replaced by actual area as it is completed.

CONSTRUCTING CROSS-SECTION PROFILES

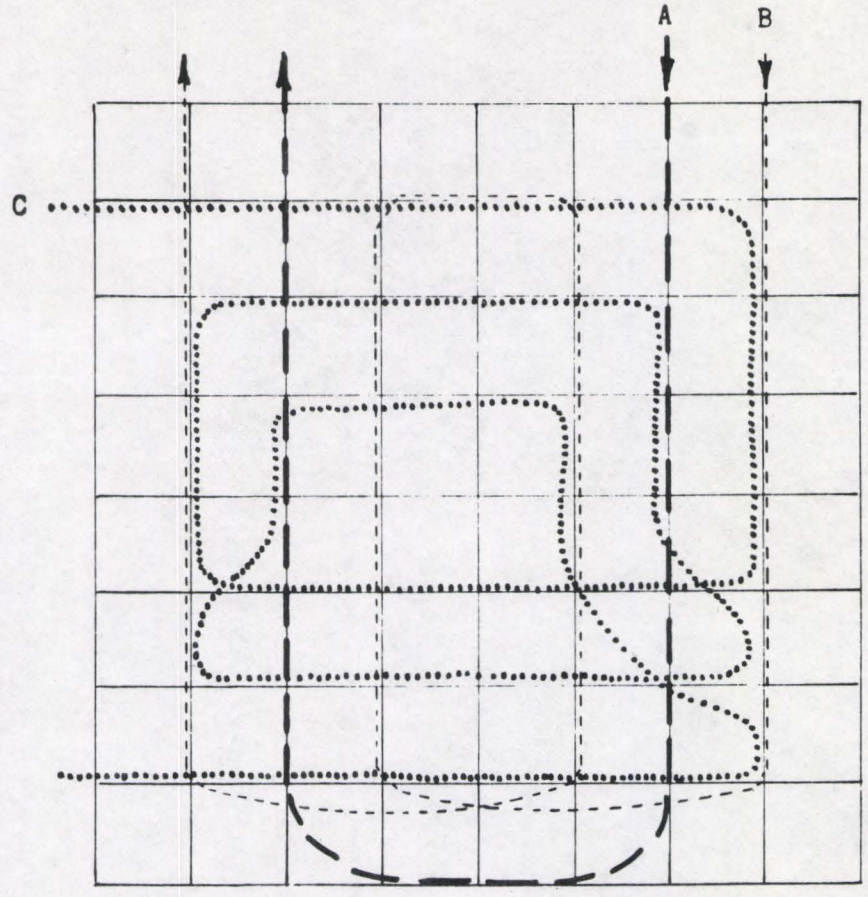
Cross-section profiles are a mechanical aid to aerial mapping, selection of plane location along a patrol route, and determination of the proper patrol elevation. See figure 9. During the preliminary planning only a few are made to serve as a check in the selection of patrol routes. Refinement of the plan will require a considerable number.

Using the contoured map as a base, the cross-section profile represents the various ground elevations as shown on the map along a straight line drawn approximately at right angles to the line of flight. The angle and location of each cross-section profile should be indicated on the base map for future reference. Each profile should be numbered to correspond to the line drawn on the base map.

By proper orientation on the seen-area composite it is also possible to indicate the areas seen by fixed detectors directly on the profile. This is of considerable help in selecting the position of the patrol plane, at that point along the course, which will give the greatest amount of new coverage. It is also possible to locate other important areas, for consideration in the selection, in the same manner.

FIGURE 10

THEORETICAL AIR COVERAGE PER MILLION ACRES



40 mi. x 40 mi. = 1,024,000 Acres

Patrol A — — — 100 miles long - Area 20 miles wide
Average coverage 54.5%, Double-up 1.2%

Patrol B - - - - - - - - 180 miles long - Area 10 miles wide
Average coverage 78.1%, Double-up 27.3%

Patrol C ..... 270 miles long - Area 10 miles wide
Average coverage 91%, Double-up 36.8%

Frequency of Observation

1. A 1-hour patrol over 1,000,000 acres has a frequency of observation of "1." Each part of the area is seen only once during the hour.

2. If one plane is in the area for 2 hours, the frequency of observation is "2."

3. If one plane is in the area for 3 hours, the frequency of observation is "3." When the area is larger than 1,000,000 acres, two or more planes are required to obtain the same frequency of observation.

SEEN-AREA MAPPING - AIR COVERAGE

It is sometimes desirable to develop a seen-area map of the air coverage for use in planning the amount of patrol needed at various danger ratings. From sample areas we have provided some preliminary figures for planning purposes but if time is available, a seen-area map of the home area is more accurate.

There are several steps in the development of an aerial seen-area map:

1. Make mechanical profiles at frequent intervals as a check on seen area, location of patrol plane, and elevation of flight.

2. Comparison of profiles progressively along the line of flight to avoid continuous "up and down" flying.

3. A comparison of profiles to determine that the line of flight is practical and safe. Planes should not be flown closer than 500 feet above or alongside of ridges. Allow for a gradual climb to obtain elevation for crossing ridges. Avoid low flying over ridges where vertical currents or downdrafts may make flying unsafe or extremely uncomfortable. Avoid excessive elevation because the added distance between observer and possible smoke reduced chances of early discovery. See figures 11 and 12. The percent of coverage indicated is only of that area represented by the cross-section profiles from which the figure was made.

4. After locating the patrol plane on the profiles, the area that can be seen by the observer is indicated along the ground line.

5. Seen area on the ground at the base line of the profile can now be transferred to the map by dots or colored lines.

6. By interpolation between the profile locations, and with consideration given to contours to "picture" topography, the seen area is completed on the coverage map.

7. Flight checking is required to further improve the seen area. In this operation the observer should check the limits of the seen area, as shown on the map, rather than small areas shown as not seen. On another trip over the area, he should work ahead of the plane and fill in blind area shown which may be seen from a different position than that one used in the profiling operation. These may also be studied by profiling as required from various positions along the flight path.

COMMUNICATIONS

Radio communication is essential to the successful operation of the air detection unit. Each patrol plane must be equipped with a suitable receiver, a transmitter on the same frequency, or frequencies, as used by the lookouts, patrol cars, and smokechasers. It may be necessary to require that contract patrol planes be shielded or otherwise made suitable for the radio installation. Modern high-frequency (FM) sets are entirely suitable for the necessary 2-way communication.

FIGURE 11

SEEN AREA AT VARIOUS ALTITUDES
(5 miles each side of plane)

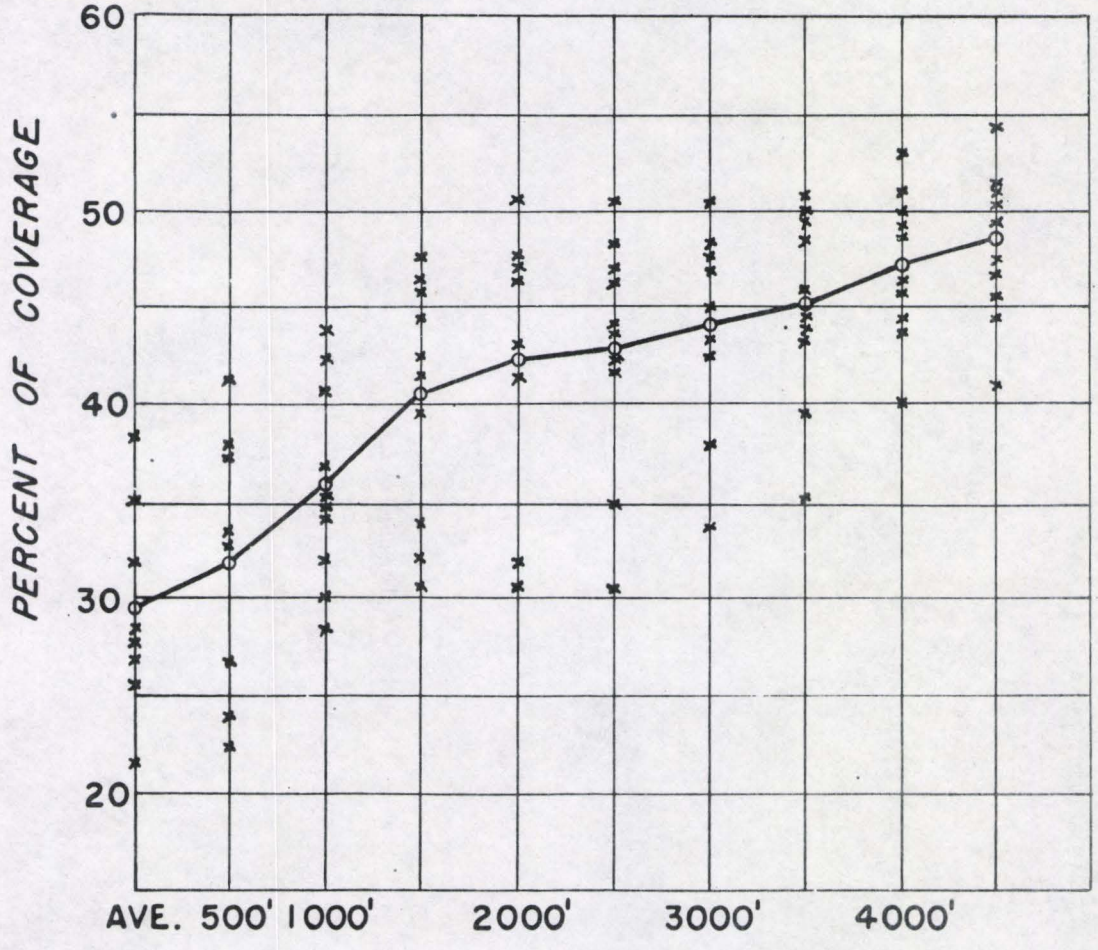
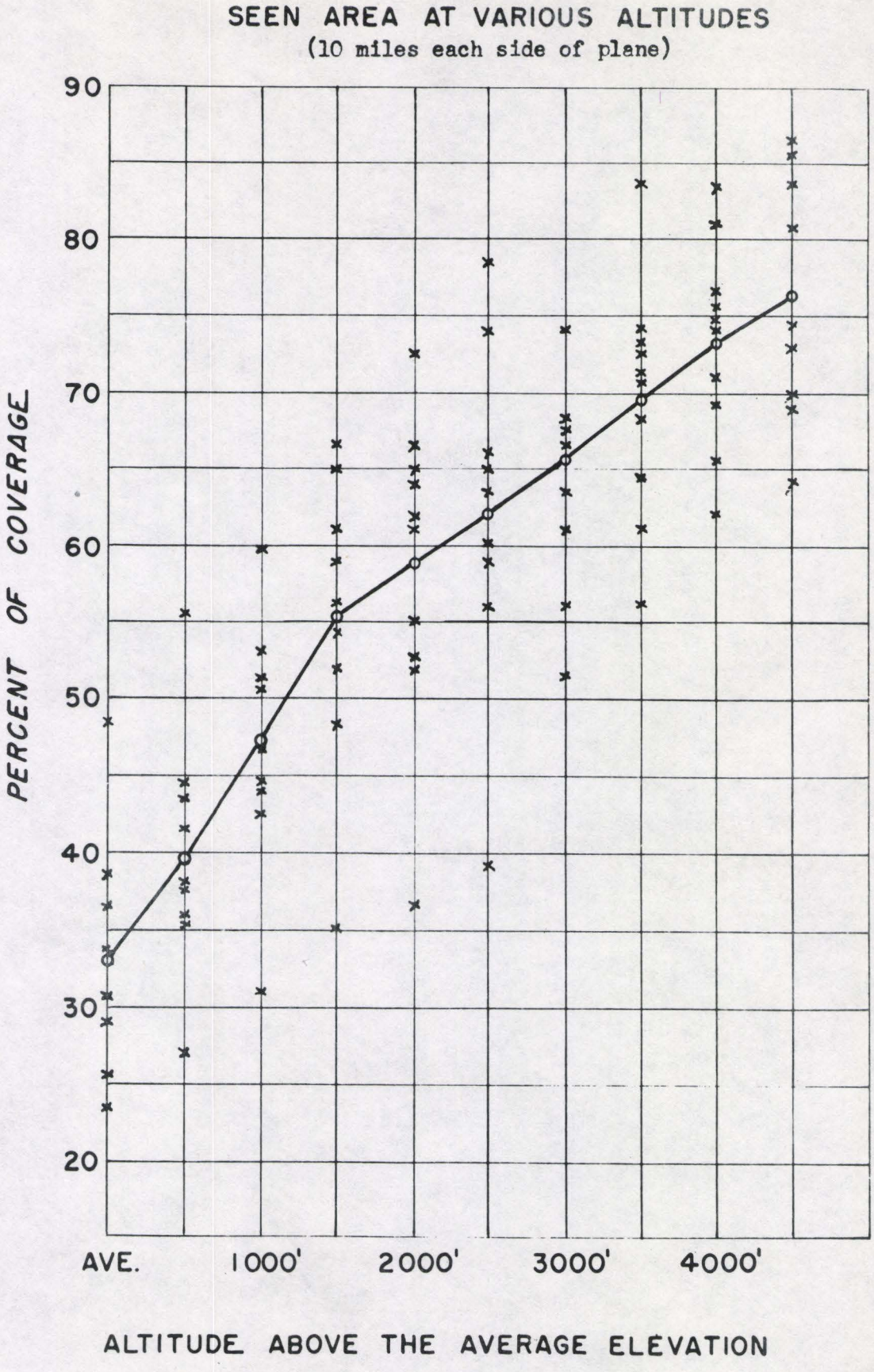


FIGURE 12


SEEN AREA AT VARIOUS ALTITUDES
(10 miles each side of plane)
PERCENT OF COVERAGE
90
80
70
60
50
40
30
20
AVE.
1000'
2000'
3000'
4000'
ALTITUDE ABOVE THE AVERAGE ELEVATION

Usually enough ground detectors are maintained in the plan that little attention need be given to their location to insure communication on any part of the area. Planners should, however, take a look at this distribution before the final coverage plans are completed to insure plane-to-ground communication regardless of atmospheric conditions or distance. As a guide use 20 miles as the maximum distance to the nearest single lookout.

Training of observers in the use of radio, particularly in brevity, is necessary if present practice of contacting each lookout while on patrol is continued. Although general lightning information is given district and forest dispatchers following each storm, the air observer will obtain the detailed information regarding strike locations and the path of the storm from each lookout as he flys the patrol route.

From this lookout data the observer can adjust the flight path as necessary to obtain detailed coverage of the strike areas. Lookouts should have strike information grouped and ready when the observer asks for the information.

Let's promote the team spirit, rather than the spirit of competition, between ground detector and air observer.

LIGHTNING-STORM COVERAGE

As in the case of the communication system, there are usually enough ground stations to report the location and extent of the lightning-storm path. Planners should, however, give a quick look at this need before final selection of ground detectors is completed. In some cases adjoining forests should be contacted to obtain complete storm information.

FIRE-WEATHER MEASUREMENT

Measurement, reporting, and the proper balance of fire-weather stations is important in the combined air-ground detection unit. In the past, fixed detectors could not be removed and replaced with each change in the danger ratings. As a result the local dangers were oftentimes submerged into the ratings for broader areas.

With the minimum number of fixed detectors, ~~who remain throughout the season once placed,~~ the possibilities of adjusting the patrol routes to effect savings in flight time are considerable. Although it took 2 or 3 days to adjust fixed detectors to fluctuations in fire danger it takes only a matter of minutes to adjust the air patrol, even in small local areas, in accordance with rapidly fluctuating weather conditions.

ORGANIZATION

The organization for the combined air-ground detection unit will remain essentially the same as for the old system with the exception of a reduced number of lookouts and an increase in the number of firemen at headquarters stations.

In some areas the requirements for district dispatchers have been reduced and a clerk substituted. This is not generally true, however, since district dispatchers are key men in most fire action. The central or supervisor's office dispatcher will have considerably more to do if the aerial operation is properly supervised. Consideration should be given to these increased duties and the requirements of out-of-season time for analysis, planning, and possibly refinement of the air plans.

One of the aims of the air-detection system is to increase the smokechasing force. Usually savings in detection can finance several short-season employees to be placed as needed according to local fire dangers.

PLANNING PERIODS OF OCCUPANCY

One very definite advantage of aerial detection is the fact that it costs little to have the patrol plane available for early- or late-season detection when fire dangers do not usually require fixed detectors or are rapidly changing from "wet to dry to wet again."

Substantial savings may be made by reducing the period of occupancy of lookouts to a minimum. Since there are only about one-third the former number, these key men can be used profitably on maintenance and other work to provide a reasonable period of employment. Planners should review carefully fire-danger and occurrence records and reappraise the periods of occupancy for the fixed-detector group.

It is seldom if ever necessary to man all fixed-detector positions simultaneously, and here again consideration should be given to the selection, priority of placement, and other conditions affecting the need for fixed detectors. The following is presented in approximate order for your consideration in planning periods of occupancy for fixed detectors:

1. From a study or review of fire-danger records, dates of fire occurrence and past actual occupancy records, select an average danger rating and an estimated date on which each position should be occupied or removed for normal detection needs.

2. Determine priority rating as indicated by placement dates.

3. Select from the top-priority lookouts those needed for early weather measurements, storm coverage, and to provide a communication system over areas with early fire dangers. In the combined air-ground detection units, approximately 1/3 to 1/2 of the ground detectors fall into this group.

4. Add training, placement time, and annual leave, in accordance with current instructions, to each position.

At least two aerial observers must be selected for the unit. These men will work under the direction of the central dispatcher. Periods of occupancy should include training and annual leave. The usual period is approximately 6 months for chief observer with a shorter time for new observers. Forests should provide additional employment if possible. Experience and qualifications for air observers require top men in the position.

Extra firemen are given short periods of employment during high fire dangers only, and are placed according to fire-danger ratings common to the area of use.

PREPARATION OF ORGANIZATION AND OPERATIONAL-COST TABLE

This table assembles organization and operation costs for the unit for discussion and comparison with previous years.

Calculation of flying costs for the average season is done by totalling the hours of anticipated patrol indicated by danger charts, lightning coverage requirements, and duration of patrols. There is no adequate mechanical means or formula for calculating the amount of patrol required for the different danger classes. This must be left to experienced judgment with consideration given to amount of coverage required for detection in accordance with the needs existing at the time. Average-season flying requirements of 12 Region 1 units planned to date, amount to $5,020.00 per million acres.

Additional funds should be planned for binoculars, glasses, modern firefinders, etc., to better equip the ground detectors for "one-shot" fire locations. The amount need not be great, however, and should be continued only as long as necessary to obtain the equipment, after which it should be placed into firegoers or additional detectors as needed.

ASSEMBLING THE PLAN

The complete plan for the combined air-ground unit should be assembled for approval or correction by the forest supervisor and the regional office. Since many who read the plan are not intimately acquainted with the unit, the plan should contain the following historical or other information:

1. Total area under protection.

2. Brief description of the area:

   a. Number of ranger districts.
   b. Topographical features - accessibility.
   c. Major timber types.
   d. Occurrence records, man-caused and lightning-caused, factors which influence length of fire season.
   e. Miles of road and trail.

3. Reasons for considering a change to the new system; inadequate improvements, reduced effectiveness due to 40-hour week, scarcity of qualified personnel, reduction of fixed detectors due to insufficient funds, etc.

4. Number of planned lookouts in the regular and emergency or overload organization in past years.

5. Percent of area covered by regular and overload positions and possibly loss of detection due to 40-hour week, or reduced manning during "easy" periods.

6. Statistics obtained by planning the new unit:

a. Percent of total area classified as "important area."
b. Estimated percent coverage of important area and total area with fixed detectors.
c. Estimated percent coverage scheduled for ~~class 70 danger~~ AVERAGE SEASON ORGANIZATION, including air patrol.
d. Number of airplanes required.
e. Number of fixed detectors, ~~class 70~~ AVERAGE SEASON
Number of emergency ground detectors, ~~class 70~~ AVERAGE SEASON
Ground patrol scheduled.
f. Communication needs.
g. Possibilities of local flying contracts.
h. Other

OPERATION OF THE AIR-GROUND UNIT

It is helpful if the operation of an aerial unit is understood by personnel engaged in planning, and it is essential that central dispatchers and others recognize the importance of continued and aggressive supervision and checking. Aerial detection, properly supervised, has proved to be a wonderful addition to our detection system.

Methods outlined here for operation of the unit, as well as for planning, are based upon a comparatively short period of time and upon insufficient records to develop the best methods or procedures. Fire control men will find much to investigate, to weigh and check, and many improvements to be made. The possibilities for original thinking are unlimited.

SELECTION OF KEY PERSONNEL

Central Dispatcher. Should be a man with considerable experience in dispatching procedures and in planning. Willing and able to "dig" into the results and make or suggest corrective action as needed.

Aerial Observers. Should be experienced in fire behavior, fuels, weather measurements, and fire suppression. If possible, should understand calculation of fire probabilities, fire dispatching, and planning methods.

It is usual for the aerial observer to relieve the central dispatcher at times during the fire season and to conduct a large share of the planning in connection with refinement of patrol routes, seen-area mapping, and record keeping.

Primary Lookout-Firemen. Lookouts should be selected carefully for experience and/or ability to understand and perform duties connected with this position. A reduced number of positions requires that lookouts locate fires at greater distances and often by "one-shot" methods. Lookouts should be trained in principles of seen-area mapping, the use of vertical angle in fire location, the graphic computation of fire location using vertical-angle readings, and methods of intensive observation.

Pilots. Usually patrol planes are contracted by the regional office with consideration for any recommendations made by forest supervisors. Pilots are carefully screened for ability, safety, and interest in the work. They should be given training in observation and made fully acquainted with patrol-route planning on the unit. We have many instances where pilots have detected smokes before the observers, in fact the pilot is often made responsible for detection on his side of the plane.

TRAINING OF AIR OBSERVERS

Aerial observers should be given thorough training in the following:

1. History and organization of the unit.

2. Planning techniques and mechanics used in arranging the air unit:

   a. Patrol routes, classes, and schedules,
   b. Aerial seen-area mapping.
   c. Coverage composites from fixed detectors.

3. Techniques and responsibilities of aerial observation.

4. Fire scouting.

5. Fire location and reporting.

6. Fire suppression.

7. Advanced map reading and use of photographs.

8. Radio.

9. Drop methods.

10. Flight safety

11. Escape training and survival after forced landing.

Some flying should be scheduled for training of observers and familiarization of pilots and observers with the patrol routes. Observers should study the areas constantly until patrols may be taken without reference to the map except for fire location. Stress the importance of using the same flight path as closely as possible.

REFINEMENT OF PATROLS AND COVERAGE MAPS

It was mentioned before that final and detailed arrangement of the patrols was not contemplated in the early planning of the units. Much of this work has been left for aerial observers. Patrols were planned only as needed to obtain a fairly accurate estimate of flight time for the financial part of the plan.

Refinement of patrols and seen-area maps should be a continuing project. Adjustments to the plans should be made currently. It is probable that when air-coverage maps are completed and checked, the ground detectors may need some revision as to number or distribution.

Air observers should construct cross-section profiles at frequent intervals along the various patrol routes. Quite often a single profile can serve for two or more flight positions in calculating area of coverage, elevation of flight, or in making seen-area maps.

Seen-area maps may be developed mechanically in the office and checked, area by area, on patrol flights. It is better to plan a series of checks, taking only a small area at a time, than to do too much checking on one trip. Until the patrol routes are carefully selected by use of a considerable number of cross-section profiles, the seen-area maps should be regarded only as temporary.

Some forests do not have contoured maps. If such is the case the patrol routes must be carefully selected by:

1. Visual selection using such topographic features as are available on the maps.

2. Patrol or training flights to check plane location in the area.

3. By knowledge of the topography as remembered by field men.

SUPERVISION OF PATROL FLYING

This responsibility is assigned directly to the central dispatcher who must decide on type of patrol, frequency of patrol or observation, and direct the air observers as necessary. Dispatchers must understand and use collectively the following:

1. Fire-danger measurements throughout the unit, and areas covered by danger-rating stations.

2. Rain maps showing wet and dry areas.

3. Special hazards such as current logging operations, berry picking, right-of-way burning, etc.

4. Weather forecasts.

5. Location of storm areas and intensity of strike activity.

6. Location and status of going fires.

7. Current information regarding fire discoveries from both air observers and fixed detectors.

The dispatcher will find many discrepancies in the original planning, during the first season of operation, particularly in the amount of patrol required at various fire dangers. Only a continuous study of fire discoveries, elapsed times, and the suppression action will provide the necessary information and experience

needed for improvement. Much of the information needed for this phase of the planning was not available and must be gathered progressively.

Dispatchers should keep these special records currently:

1. Number of first discoveries and size on discovery by air observers.

2. Number of first discoveries and size on discovery by lookouts.

3. A running record of elapsed times: origin to discovery and discovery to report, for making or planning corrective action.

4. Class of patrol, time of patrol, duration of flight, and the fire danger (actual or forecast) at time of patrol.

5. Location, size, and distance from observer of fire discoveries. Location checked on seen-area maps.

6. Lightning-storm information needed to improve patrol routes and particularly to determine supplemental flight requirements with relation to intensity.

For any analysis made, the dispatcher should have in mind the danger ratings and other measureable factors which will serve as future indicators or guides to amount and frequency of patrol, number of fixed detectors, etc., needed to obtain satisfactory speed of discovery. This field is open for progressive thinking and action.

SAFETY OF PATROL FLYING

Dispatchers and observers should be familiar with C.A.A. regulations which pertain to flight safety and should be on the lookout for any unsafe practice or equipment.

It has been the practice to inspect all contract airplanes and flight check all pilots prior to contracting for patrol flying. This is usually done by Forest Service pilots. Observers should, however, check occasionally to make sure of strict compliance with C.A.A. requirements regarding periodic inspections and overhauls.

All air observers should receive escape training and instructions in adjusting and using the parachute required for patrol flying. Parachutes should be repacked as necessary.

Pilots are the final authority on unsafe flight conditions and will at no time be urged to fly against their judgment.

INFORMATION FROM FIELD STATIONS

Dispatchers must arrange for current information from the field for use in scheduling patrol or other flying. Lightning storms and intensity of strikes should be reported as soon as possible following the storm. It has not been the general practice to report the strike locations but rather the area covered by the storm and the number of individual strikes observed. A patrol may or may not be scheduled following every storm. This depends upon the burning

conditions, weather or flight conditions, time of day, area to be covered, and other considerations. If patrols are needed, the dispatcher should have this information for planning direction of travel over the patrol route or combining two or more types of patrols as needed.

REVISION OF PLANS ANNUALLY

An annual revision of the detection plans should be made, giving careful consideration to:

1. The patrol schedules and danger ratings.

2. Analysis of storm occurrence.

3. Fire occurrence, fire action, and elapsed times.

4. Seen areas from airplane and lookouts.

This revision is of particular importance during the first few seasons of operation. Adjustments should be made before costly improvements are built or abandoned.

REPORT OF RESULTS

Many of the air detection units now in operation were approved by the Washington office and the regional office on a 3-year trial basis. Continuance of the plan is dependent upon the success of the operation during that period as shown by a comparison of results with previous years. From analysis made to date, there appears to be little question about these results, if the unit is properly supervised and plans currently modified as needed. A brief annual report of the operation during the initial stages with graphic comparison of the fire action is desirable.